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SOME BIOLOGICAL CONSIDERATIONS OF THE 1940-1941

MT. LAGUNA RECREATIONAL AREA CONTROL JOB

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MT. LAGUNA RECREATIONAL AREA CONTROL JOB

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SOME BIOLOGICAL CONSIDERATIONS OF THE 1940-1941 MT. LAGUNA RECREATIONAL AREA CONTROL JOB

DESCRIPTION OF AREA

The Mt. Laguna Recreational Area of the Cleveland National Forest is an intensively used summer-home site unit of about 15 sections some 50 miles east of San Diego. Approximately three-fourths of the area is timbered, the stands being composed chiefly of relatively young growth of Pinus jeffreyi. Pinus coulteri and Quercus kelloggii are the principal minority species. For the most part the soil is rough stony land with Foster sandy loams in the larger draws. These soils consist of micaceous, friable, sandy loam with excessive drainage where the land is rough and stony. The depth of the underlying rock is quite variable, at times being several feet deep, at others almost bare of soil. Tree growth, on the average, appears to be fairly good; trees increasing in diameter as much a 7 inches in 10 years have been observed. Mistletoe infected trees are scattered throughout the stand but there are certain areas where the infection is especially common and heavy. The conditions found in the area appeared to be localized and were not observed in other areas of Southern California or in the Sierra.

PREVIOUS OBSERVATIONS

Asfar as Bureau records go the first inspection to determine forest insect conditions of the Mt. Laguna area by this division was made by Keen[1] in December 1926. He reported that Jeffrey pines in groups of from two to eight small to medium sized trees had been killed in the last few years. The killing was principally the work of Melanophila californica although a few small trees had also been killed by Ips oregoni. In addition, Keen says, "It is evident that the flat-headed borer has been working rather slowly, killing only one or two trees in a group each year and continuing in the same locality until the group has become conspicuous with the old trees representing several years' loss.

In 1930 Salman[2] reported an infestation caused "almost entirely... by flat-headed borers. The insects are not vigorous in their attacks, but follow their attack on one tree in one season by attacks on surrounding trees in the succeeding seasons, so that a group of dead poles is the result."

CONTROL WORK

In an effort to reduce these losses control work was first carried out over a portion of the area by the Forest Service in 1929,[3] and since then

1 - Keen, F.P.: Memorandum of the examination of insect conditions in Cleveland Nat. Forest and Vicinity, San Diego, Cal. Stanford Univ. January 5, 1926.

2 - Salman, K. A.; Memorandum concerning insect conditions, Cleveland Nat. Forest. Oct. 1930, Berkeley, Calif. Nov. 6, 1930 (M.S.)

3 - Ibid.

in 1931, 1933, 1934, 1937, 1938, 1939 and 1940[4]. During this period a total of 5432 trees have been treated. The number of trees from the 1940 infestation alone amounted to a total of 4132.

Last fall for the first time an attempt was made to cover the entire area with a 100 percent survey. The infested trees were numbered, mapped in, and the insects believed responsible for the trees' death were recorded. This report deals only with the entomological aspects of the survey work carried out last fall.

TYPES OF INFESTATION

The first day of survey work indicated that the infestation was not a simple one. All sorts of infested trees ranging from green to dying or partially dying were present in the area. Later examination revealed that several different insects and a fungus were apparently involved in the infestation. These are listed below:

1) Root Fungus
2) Melanophila californica
3) Ips oregoni
4) Cerambycid
5) Cylindrocopturus sp.
6) Combinations of the above five classes.

ROOT FUNGUS

Armillaria mellia, or a species similar to it* was commonly found around the root collar of dead and dying trees. Most of the older infected trees were infested with insects while the younger trees (0-6" dbn) were not. The fungus apparently works from the smaller roots up into the lower main stem. On the main stem it has been observed only for a short distance above the root collar (Fig. 1). Infected trees are scattered throughout the region, but there are limited areas where the infection seems to be more concentrated and within these areas there appear to be points of infection from which the fungus spreads causing circular areas of kill which are quite distinctive (Fig. 2).

The foliage of trees which appear to have been killed by this fungus alone turns a peculiar yellowish green that could not be mistaken for any other type of fade. Above the root collar the bark on these trees is dry and tight; at and below the root collar the bark is moist, loose, and easily separated from the wood which is usually covered with a dense layer of white hyphae. The wood of the root collar and roots often displays areas of heavy pitch infiltration. Only occasionally are secondary insects found attacking such trees as those described above.

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4 - Carlson, S. T.; Review of the 1939-40 insect control projects; Lagunas, Pine Valley, and Corte Madera units, Cleveland Nat. Forest. May 1, 1940, Berkeley, California (M.S.)

* - Determination by Dr. W.W. Wagener.

Many of the trees in which the attacks by Ips oregoni and Melanophila californica appeared to be primary may have first been attacked and "weakened" by this fungus which had not yet developed sufficiently far for hyphae to form at the root-collar. One point, however, is certain and that is the rather widespread occurrence of trees which judging from the color of the fading foliage have been primarily attacked by Ips oregoni or Melanophila californica, but which showed fungus at the root collar. This shown by table 1 below:

Table 1. Frequency of Root-fungus in Beetle Infested Jeffrey Pine Trees*

	Type of Infestation and Number of Trees Infested					
	Pure Flathead Attack	Pure R'ndhead Attack	Mixed Fh.&Rh. Attack	Pure Ips Attack	Mixed Ips & Rh. Att.	TOTAL
Fungus at Root-Collar	143	0	70	80	12	305
No Fungus at Root-Collar	133	0	70	33	8	244
Total	276	0	140	113	20	549

Table 1 shows that slightly more than half of the 549 trees marked for treating had fungus at the root-collar. It is possible that most of the trees which showed no fungus were infected but not sufficiently so for this to be determined by root-collar examination. As dying but non-insect infested trees were not marked for treating, we have no available record of the frequency of their occurrence.

In an effort to determine whether evidence of recent root-collar infection would be detected by a slowing down of tree growth, cores were taken from various types of trees. The following table shows the growth rates of infected, infested, and apparently vigorous Jeffrey pine trees during the past nine years. This nine year period has been subdivided into three year periods. The increment during the last three year period (1938, 1939, and 1940) is expressed as a per cent of the total increment for the previous 6 year period, and, again as a per cent, of the increment that occurred during 1932-34 and 1938-1940.

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* Based on random examinations made during the winter by L. R. Swenson of trees marked last fall for treating.

Table 2 - Percent growth of last three-year period ('38, '39, & '40) in relation to the growth during the two previous three-year periods ('35, '36, and '37, designated as period A, and '32, '33, & '34, designated as period B).

Tree No.	Period A	Period B	Risk Classification	Remarks
1	56.6	54.3	I	Healthy green tree.
2	51.0	57.6	I	"
3	48.7	57.3	I	"
4	59.5	61.9	I	"
5	43.6	51.9	I	"
6	53.0	48.8	I	"
7	57.9	61.5	I	"
8	53.3	61.2	I	"
9	62.1	59.9	I	"
10	66.0	69.1	I	"
11	59.6	56.4	I	"
xc	25.0	20.6	II	Roundheads only--in bole
23c	53.0	31.8	IV	Fastgrowing flatheads. No fungus at root-collar. Roundheads in bole.
xb	47.2	25.0	I	Roundheads in bole. Some incipient work.
Xa	56.0	52.3	I	Only Cylindrocopturus larvae present.
519	26.7	12.6	IV	Scattered flathead work in top half only. No fungus at root-collar.
384	49.0	24.8	II	Fast-growing flatheads.
381	49.0	39.5	II	Ips oregoni in top half. Fast-growing flathead in lower half.
103	61.6	40.2	I	Ips in top half. Round-head in middle half.
143	17.8	11.7	II	Pure flathead attack.
75a	51.4	51.4	I	Pure Ips attack.
75	39.7	18.8	I	Pure Ips attack.
63	34.6	31.2	III	Ips - fastgrowing flathead. No fungus at root-collar.
23b	62.5	52.6	III	Very scattered fast-growing flathead. No fungus at root-collar.
23a	16.6	18.1	III	Scattered Ips attack. Scattered incipient flathead. No fungus at root-collar.
113b	72.3	66.1	II	Light even fads. No insects in trunk. No fungus at Root-collar.
113a	28.2	14.8	I	Scattered fast-growing flathead in galleries.
21	42.8	39.5	III	Fast-growing flathead. Root rot in collar.
xd	43.3	41.8	I	Root rot at collar. Limbs and trunk attacked by Pityophthorus.

An analysis of table 2 indicates that on the average there was a marked dropping off in the growth rate of infected or infested trees over that of healthy green trees. There seems to be no apparent correlation between growth rate and incidence of root-collar infection in the data at hand. These, however, are obviously inadequate and if further work is to be done in the area it would be well to make a more detailed study in this field.

MELANOPHILA CALIFORNICA VAN DYKE

Melanophila californica was widespread in Jeffrey and Coulter pine. No final figures are available concerning the total number of trees infested by this insect but table 1 shows that of a random sample of 549 trees marked for treating 50.2 per cent were pure flathead infestation, 25.5 per cent were mixed flathead and roundhead infestations, and 3.6 per cent were mixed flathead and Ips oregoni infestations.

Whether this beetle is the primary cause of the death of these trees or whether they develop only or chiefly in trees with the root-rot cannot be said until further study is made of the situation.

IPS OREGONI LECONTE

A small outbreak of Ips oregoni represented by top-killed trees, was present in the area (Fig. 3). Of this infestation (based on the data mentioned above), 20.6 per cent was pure Ips, and 3.6 per cent was mixed Ips and flatheads; 69.1 per cent of the Ips infested trees showed root-collar infection. This is rather surprising as preliminary examinations did not reveal such a high incidence of infection.

CERAMBYCID*

A distinctive type of infestation in Jeffrey pine was quite noticeable especially around Filaree Flat and in part of S 4, T 15, S, R 5 E. This infestation was characterized by dead branches or by clear pitch globules on the bark, and by patches of deep woodpecker holes in the bark of the trunk of green trees. Quite frequently the base of the dead limbs of the green trees would also have woodpecker holes. In all cases examined, it was found that cerambycid larvae were present (Figures 4A & 4B). Most of the larvae observed were nearly full grown, but others were less than half grown. Root-collar infection was present in some of these trees but in others none could be observed. As there was no evidence that these insects were primary, trees infested by them were not marked for treating.

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* No adults have yet been secured, nor can the larvae be placed other than in the Cerambycidae.

CYLINDROCOPTURUS

The most apparent and the most widespread infestation (but of slight economic importance) in the entire area was that of a weevil, Cylindrocopturus sp. The infestation is confined chiefly to mistletoe infested branches, and trees with this type of infestation were not marked for treating.

As mentioned above mistletoe, Arceuthobium campylopodum, is prevalent throughout the Mt. Laguna area, and it has been suggested that the dead and dying tops and branches of many of the Jeffrey and Coulter pines was due to mistletoe infection. Preliminary observations indicate, however, that it is probably the activity of this weevil's feeding in the mistletoe, or at least in the areas infected with the mistletoe, which is responsible for this dying of tops and branches.

Almost invariably, examination of green mistletoe on green limbs will disclose very small Cylindrocopturus larvae working in the base of green mistletoe stems, and it is not uncommon to find dead larvae in the base of dead stems. Dead Jeffrey pine twigs as a rule have nearly full grown Cylindrocopturus larvae in the mistletoed areas and almost invariably these areas are bluestained* (Figs. 5A,B,C and D).

The weevil is occasionally found in dead twigs without mistletoe; in one case larvae were found in a green twig with no mistletoe, and bluestain is occasionally found in dead twigs with no evidence of weevil work. It would thus seem that the activity of the weevil is not confined to mistletoed areas, and that bluestain may possibly enter a twig at times without the aid of the weevil. There seems to be little doubt, however, that the weevils prefer mistletoed areas in which to oviposit. As adult Cylindrocopturus have not yet been reared from non-mistletoed infested twigs it is possible that two species may be concerned in the infestation. A great deal more biological work is necessary before the complete habits of the beetle can be known.

"X-Trees"

Scattered throughout the forest were many trees which appeared to be dying in whole or in part but to which, at the time, no cause for the dying could be given. A record was kept of the number and distribution of these trees which were listed as "x-trees". At the conclusion of the spotting work last fall a total of 446 "x-trees" had been recorded. For the same area 1301 trees had been marked for treating.

During control work this spring Mr. Swenson was able to make a more careful examination of many of these "x-trees" and of the trees that were passed up by the spotters, than was possible while the spotting work was being done. He found that 70 of the "x-trees" should have been marked for treating; of these 70, forty had fungus at the root-collar. In addition to the "x-trees" many more were either passed up or missed by the spotters that should have been marked for treating. From these observations it is obvious that more time should have been spent in examining all types of trees, but it is also obvious that it was quite impossible to climb every tree marked as an "x-tree", or which appeared doubtfully infested, to check on the presence of infestation higher up the tree beyond the reach of an axe.

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* Dr. Rumbold has determined the bluestain as a species of Hormiscium.

DESCRIPTION OF THE APPEARANCE OF THE TYPES OF INFESTED TREES.

Although brief mention has already been made of the appearance of certain types of infested trees, a summary of the appearance of all the types recognized last fall seems advisable.

Type of infestation	Appearance of affected trees.
Root-fungus	Small trees (0-6"dbh). Foliage off-color, greenish-yellow to yellow. Larger trees (6"-24"+dbh). Infection could not be recognized except by examination made by chopping into phloem in region of root collar. Insects present in bole or branches and fading foliage appeared to be caused by insect activity.
Melanophila californica	Foliage green to faded; bark scaled off trunk in patches by woodpeckers. Fade rather uniform.
Ips oregoni	Fade usually in top of tree and shading out down the bole to green needles. Bark gone in large patches owing to woodpecker work.
Cerambycid	Foliage for the most part green; a few branches with red needles often present. Small holes made in bark on bole by woodpeckers.
Cylindrocopturus	Scattered dead twigs on green branches throughout tree. Sometimes only a few twigs dead, at other times several dozen dead twigs.

Trees were occasionally observed with all five types of infestation present. A mixture of two types was perhaps the rule so that the descriptions of these various types should no be considered as clear cut ones but rather as rough guides to the characters used by the spotters in marking trees for treating.

IS EXTENSIVE INSECT CONTROL WORK WARRANTED IN THIS AREA?

This is a difficult point to decide. Conditions in 1940 had probably accentuated factors, not caused by insects, which were contributing to the deterioration and the death of many of the trees. If the fungus is furnishing host material attractive to Ips oregoni and favorable for Melanophila development then it would seem reasonable to continue control work until conditions which apparently are now favorable for the development of this fungus, have subsided. If control work were not continued while the fungus is rampant it is possible that a severe outbreak of these two beetles would occur.

On the other hand if the fungus has nothing to do with the widespread presence of beetle infested trees, then it would seem that control work would be warranted only in the camp ground areas and on summer home-site lots.

66NCLUSIONS

It seems apparent (1) that until a thorough study is made of the relation of the root-fungus to the presence of insect infested trees no satisfactory program for the prosecution of insect control work can be drawn up; (2) that not enough is known of the insect infestation to do a fully satisfactory job of spotting; and (3) that until more is known about the fungus and the role of the insects discussed above the safest policy would be a continuation of the control work as it is now being carried out.

It is planned that further studies will be made in this area next fall in an effort to clear up some of the points brought up in this report.

ACKNOWLEDGEMENTS

The survey last fall was carried out by L. R. Swenson of the U. S. Forest Service, and Gilbert Acosta, Noel Street, and the writer. S. T. Carlson headed up the work for the first week of the survey after which resigned to take a new position. Mr. Swenson headed up the control work in the field during most of the period, and made the observations and took the records mentioned above at that time. In addition to this he assisted in making the stem analyses last fall and later secured additional cores that were needed.

Fig. 1 Root-rot hyphae at and above root-collar of small Jeffrey pine. Mt. Laguna area. March 1941

Fig. 2 Circular area of old and recent Jeffrey pine killings. Such areas are possibly primarily caused by a root-rot.
April 1940

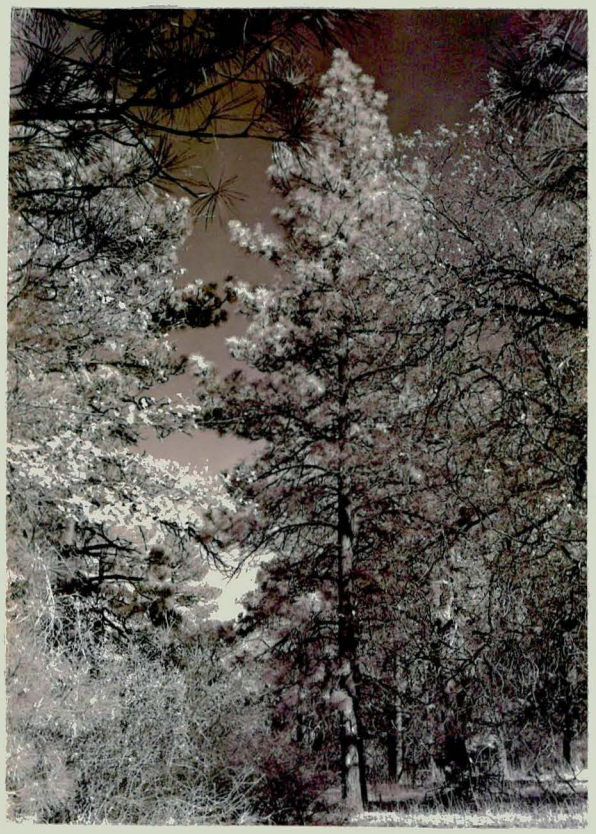

Fig. 3 Jeffrey pine killed by Ips oregoni attacks. Many of these trees showed fungus at root-collar. October 1940

Fig. 4 Woodpecker holes in bark of green Jeffrey pine tree, from which the birds have removed roundhead larvae. Jack-knife points to clear resin globule possibly caused by roundhead injury. October 1940

Fig. 5 Same as figure 4 but bark removed showing roundhead galleries. Note absence of incipient flathead work. October 1940

Fig. 6 Living mistletoed branches of Jeffrey pine. Such areas are usually heavily infested with young Cylindrocopturus larvae. Note patch globules probably caused by weevil punctures. October 1940

Fig. 7 Green, mistletoed twig with bark removed. Arrows point to pits from which small living Cylindrocopturus larvae were removed. March 1941

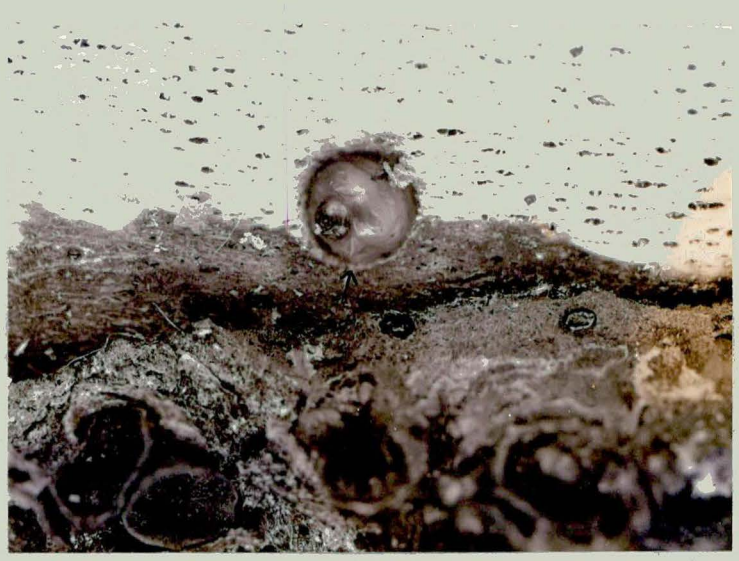

Fig. 8 Full grown Cylindrocopturus larvae in mistletoed area. Bluestain has not yet developed. March 1941

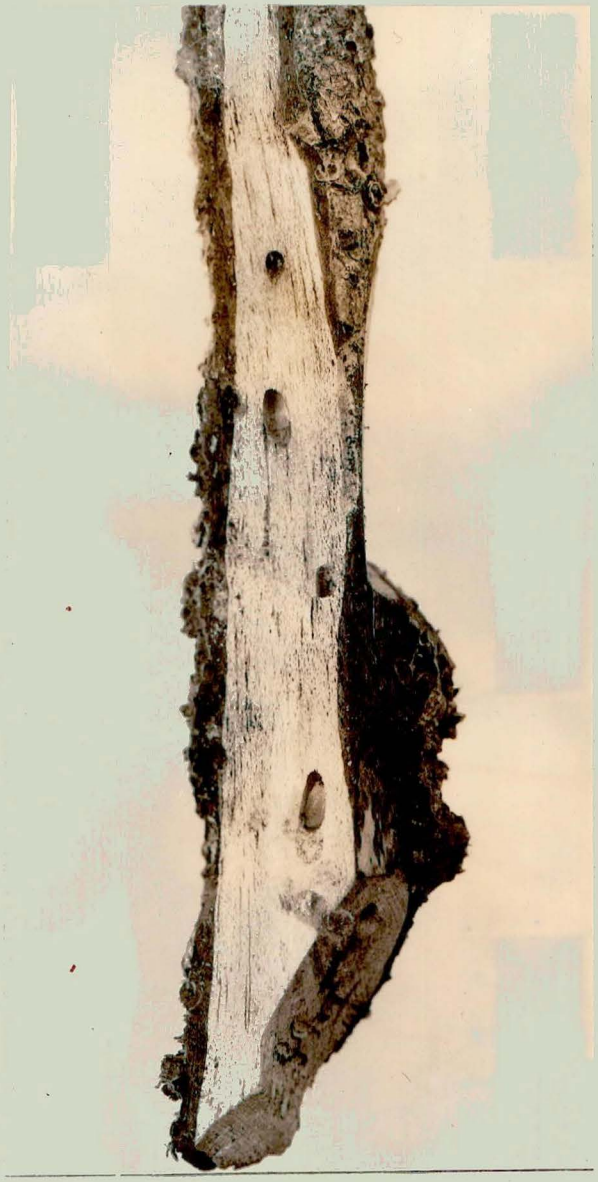

Fig. 9(Fully grown Cylindrocopturus larvae in mistletoed area in which bluestain has developed throughout most of the zone in which the weevils are working. March 1941